Towards abundance estimates for jack mackerel in the South Pacific based on acoustic data collected by the commercial vessels

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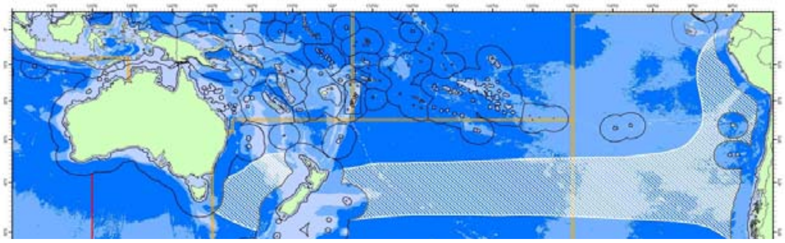

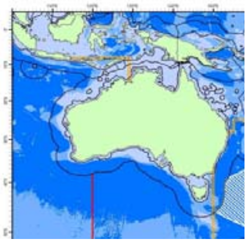

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Summary

Pelagic trawlers make intensive use of echosounders and therefore could potentially be used as acoustic data collection platforms. This project investigated the possibility of collecting acoustic data and its potential utility to estimate fish stock biomass. The scope of the project was to develop and - when possible - test the tools that would be necessary for large scale data collection from commercial vessels, and investigate the suitability of acoustic data to derive abundance indices.

Within this project, an external hard disk was installed on board a fishing vessel and 8 months of acoustic data were recorded. This experience proved that data collection from commercial vessels was relatively easy, but susceptible to technical problems. This experience proved very useful as it provided insight for planning future data collection schemes.

A programme was written to extract the raw data, process the acoustic information according to standard scientific methods and produce output files in an appropriate format. Preliminary testing indicated that this program successfully processed the raw acoustic data, but suggested also that a better knowledge of the proprieties of this data is required. Some methodological developments, regarding for instance species identification, are also needed to improve this programme. Additionally, a database model was developed, with an importation procedure, to store these files in the IMARES database.

A fishing simulator also was built to generate modelled acoustic data, which can then be used to test the suitability of acoustic data collected by commercial vessels for estimating abundance indices. This tool is now operational and can be used to test different methods to derive abundance indices and assess their accuracy and potential biases.

Finally, this work pointed out that the success of this approach requires information and knowledge exchange between fishers and scientists. Scientists have to know more about the acoustic equipment installed on board fishing vessels, and about how it is being used by the fishers. A better understanding of the fishing behaviour is also important. Along with the acoustic data, information on the catch (species and size composition) may also be required. Fishers would need to know how to handle the data storage device and they will have to calibrate their echosounder and to apply some standard settings for their acoustic equipment.

Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 57846-2009-AQ-NLD-RvA). This certificate is valid until 15 December 2012. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2013 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

Assignment

Wageningen IMARES was requested to realize and report on the following tasks :

1. "Aan boord van een voorgeselecteerde trawler wordt de akoestische apparatuur klaargemaakt voor automatische dataverzameling. De bemanning wordt geïnstrueerd hoe deze apparatuur te gebruiken en hoe te handelen bij uitval/storing. Mocht dit werk voorspoediger gaan dan verwacht dan kunnen meerdere trawlers worden betrokken."

2. "Met LNV en de rederij worden afspraken gemaakt over standaardisatie van het verzamelen van VMS en vangstgegevens; ook van de trawlers die varen onder buitenlandse vlag."

3. "Binnen IMARES zal gewerkt worden aan een automatiseringsprocedure om akoestische gegevens om te zetten in visdichtheids; en verspreidingsinformatie. Hiervoor zullen eerder ontwikkelde buitenlandse initiatieven gebruikt worden als basis."

4. "Binnen IMARES zal gewerkt worden aan het op elkaar afstemmen van binnenkomende gegevens en het uiteindelijke gebruik ervan in het in 2007 ontwikkelde simulatiemodel."

5. "In samenwerking met de bemanning van de gekozen trawlers zal een protocol worden opgesteld voor het verzamelen, verwerken en presenteren van commerciële gegevens. Er wordt naar gestreefd een gestandaardiseerd verslag van alle resultaten te generen na iedere visserijperiode."

1. Introduction

1.1 Background : the jack mackerel fisheries in south pacific and the research ongoing

Jack mackerel is an important fishery resource in the South Pacific. After an increase from 0.2 million tonnes in the 1970s to more than 4 million tonnes in the mid 1990s, the catch has decreased to about 1.5 million tonnes in the late 1990s and is know oscillating around this value (SPRFMO, 2008). This species is highly migratory and is distributed throughout the Southern Pacific, but most of the catch is taken on the eastern part of the South Pacific. Firstly limited to the Chilean and Peruvian EEZs, the fishery expanded westward to the high (international) seas and new flags, such as China, Korea, Russia and the Netherlands, joined the fishery.

The stock is currently assessed in the framework of the South Pacific Regional Fisheries Management Organization (SPRFMO). An analytical stock assessment (using similar models as used in the ICES context) is carried out annually, based on an analysis of historical catch at age data. Those models have too much freedom (i.e. to many parameters to be estimated from too few data), and therefore need to be tuned, i.e. forced to mimic the abundance indices independent from the catch at age data used in the model. Such independent indices are provided by direct estimation of the stock by acoustic surveys carried out annually by Peru and Chile in their respective EEZs. But the international area is too wide to be covered by a scientific survey. The data available for the offshore part of the stock only relies on the information collected onboard of the commercial vessels.

About 10% of the catch in 2007 was taken by EU vessels, most of them being owned by Dutch pelagic fishing companies. Therefore the Dutch government decided to participate in the research effort aiming at getting a better knowledge on jack mackerel and its fishery in the South Pacific. The Dutch Ministry of Agriculture, Nature and Food Quality commissioned a three years program consisting of 3 parts : (1) an observer program, (2) financial support to a FAO working group on South Pacific jack mackerel and (3) a study on the feasibility of collecting acoustic data from commercial vessels and using them to improve stock assessment. IMARES was requested to conduct the latter study (3), in cooperation with the Dutch pelagic industry.

The present document reports the work done during the second part of this project, realized in 2008-2010. A report for the first part of this project, which was carried out in 2007-2008, has already been issued (Ybema et al., 2008)

1.2 scientific question : can stock abundance be estimated using acoustic data from commercial trawlers?

Scientific acoustic surveys are commonly used to provide abundance estimates of pelagic fish stocks. For some species, it is possible to convert the acoustic information into biomass, and estimate the absolute biomass of the stock. When it is not the case due to unknown acoustic target strengths, or when the fish behaviour is such that part of the stock can not be detected, acoustic surveys still can provide relative abundance estimates. If a survey is carried out regularly in time (e.g. annually), such relative indices can help track the temporal variations of stock size. This is a valuable information which can be used to improve the accuracy the outputs of stock assessment models. The are however a number of shortcomings related to acoustic surveys. As with any scientific survey, they are limited in time, due to the cost and limited availability of research vessels. Therefore, they only provide a “snapshot” of the spatial distribution of the biomass of a stock.

As the quality of echo-sounders used onboard commercial vessels has improved, they can now deliver acoustic information up to the standard required for a scientific use, although the sounders still need to be calibrated at regular intervals to ensure consistency over time. As a consequence, commercial vessels are increasingly used instead of or in combination with research vessels to perform acoustic surveys. However, very few attempts have been made to use the acoustic information collected by commercial

vessels during regular fishing trips. This practice could prove very useful for a number of reasons. First, the additional price associated to the collection of this extra data is very low, and only related to the installation onboard of a device to store numerical data and the post survey analysis. Besides, since a fishing season generally extends over several months, and as many vessels can potentially deliver their information, the spatial and temporal coverage of fishing vessels data would be much larger than for a scientific survey. Finally, this would improve the collaboration between scientists and fishers, and increase the participation of the fishers in the process of stock management.
Despite all these considerable "pros" for the use of acoustic data collected during fishing trips, deriving abundance indices from these data may also raise a range of scientific issues :

1) technical considerations :

    a. to be able to convert the acoustic information to fish biomass, the echo-sounders present onboard commercial vessels have to be first calibrated. If this operation is not conducted, only relative abundance indices could be calculated, and information from different vessels will not be comparable. Also consistency of each sounder over time cannot be guaranteed, therefore it might be necessary to repeat the calibration several time during the year.

    b. Technical and logistical questions regarding the collection of the data should be resolved

    c. A functioning data management system needs to be set up to be able to cope with the large amount of data that would be collected.

2) methodological considerations :

   Scientific surveys have a predetermined design aiming at reducing the uncertainty and bias in the estimates. Some bias can be introduced when using data collection during a fishing trip :

    a. the fishery concentrate its effort only on the areas of high density. The biomass present in the areas of less interest would therefore be inaccurately or even not estimated.

    b. Consequently, the spatial coverage of the commercial vessels data will probably not cover the whole area occupied by the stock, which could be a problem for raising local abundance estimates to a global stock abundance estimate.

    c. There is currently no standard method to compute an abundance index from these data as concentrating on the areas with greater abundances of fish will bias the estimates upwards.

1.3 Summary of the first project

In 2008, a first phase of the project was realized at IMARES with two main goals :

1) to investigate the usefulness of acoustic data collected by commercial vessels for stock abundance estimation using a fishing simulator

   A tool simulating a fleet of pelagic trawlers fishing on a resource spatially distributed on a grid was developed. As the vessels move on the grid, searching for suitable fish aggregations and fishing, the information on the fish abundance present in the cells visited is recorded, thereby simulating the collection of acoustic data during a fishing trip. As the true abundance of fish present in the model is know, the accuracy of abundance indices calculated from the simulated acoustic data can be assessed. Among others, the applications of this simulator would be to :

   - compare the accuracy of different methods to derive abundance indices from commercial vessels acoustic data.
   - investigate whether using acoustic data to compute abundance indices improves the precision compared to the traditional approach based on catch per unit effort.
   - investigate how the accuracy of abundance estimates vary according to the amount of information which is available (or : investigate how much data is needed to reach a acceptable level of accuracy).

- investigate whether it would improve the quality of the index if fishing vessels modify they behaviour (e.g. doing transects as a survey during their spare time).

The development of the simulator was very preliminary and only a test run could be carried out.

2) to investigate the technical feasibility of collecting, processing and storing the acoustic data

During the first phase of the project, an overview of the different types of data that should be collected from the commercial vessels was also done. Practical considerations regarding protocol for data collection, and processing and analysis of these data were explored.

1.4 Structure of the present project

The second phase of this project was executed following 3 main lines :

1) To select fishing vessels with the required acoustic and computer equipment, install a portable data storage device to store the data in real time and teach the crew how to handle it. To realize a first test for data collection on board a fishing vessel.
2) To develop a procedure to process the acoustic data (i.e. analysing automatically the acoustic detections) using standard scientific methods applied in acoustics. To store the processed data in Frisbe, the IMARES database.
3) To further develop the simulating tool and use it to investigate the accuracy of abundance indices potentially derived from commercial acoustic data.

2. Collecting acoustic data from pelagic freezer trawlers

The echosounder of fishing vessels is operated by computer via an operating system. Most of the Dutch pelagic trawlers are equipped with the operating systems ES60 or ES70 which allow recording the acoustic data in real time on a hard disk. It is therefore relatively easy to connect an external hard disk to the computer to record the acoustic data, providing that the computer to which the sounder is connected is equipped with an up to date USB port and a modern version of Windows.
A 1Tb external hard disk was installed on board of the KW 174 Anelies Ilena in March 2010, while the vessel was preparing its fishing season to the South Pacific. The ship had just installed the new ES70, and some trial recording showed that the data was successfully logged on the hard disk. One minute of recording occupied a space of 1.3Mb on the hard disk (meaning the capacity of the 1Tb disk being 534 days of recording).
During the fishing trip, a problem with the ES70 software occurred which resulted in an interruption of the logging of acoustic data. The software had to be reinstalled and the crew managed to reconnect the hard drive and to restart the data logging. This proved that data collection and storage was relatively robust.
The hard drive was return to IMARES at the end of the fishing trip, in October 2010.

3. Processing and storing the data

3.1 Processing and formatting acoustic data

3.1.1. Principle

Acoustic data obtained from scientific surveys are usually analysed using commercially available software packages such as for example Echoview®. These are graphically oriented software packages designed to visualise, process and analyse acoustic data for scientific purposes. One of the applications of such software is to separate fish schools from the rest of acoustic detections (e.g. plankton) and to characterise them (e.g. biomass, species). For computer resources reasons, this can only be done on relatively small datasets and usually a subset of one day's data is analysed at a time during acoustic surveys.
As the amount of data collected from the commercial vessels is substantially larger than for a typical acoustic survey, Echoview may not be a suitable tool for the type of application. Hence, there was a need for an automatic acoustic data processing algorithm, that could analyse large commercial datasets and translate them into a format that is optimized to be stored within a central database.
Norwegian scientists, from the Norwegian institute of marine research (IMR), have developed algorithms in the Matlab® language that can analyse the acoustic data and return density estimates for the species targeted. Acoustic data, consisting of pings at certain locations, is translated into a density estimate over a surveyed area represented by a two-dimensional matrix of distance and depth. A description of the algorithms used can be found on: http://www.imr.no/sok/nb-no?searchString:utf8:ustring=echolab

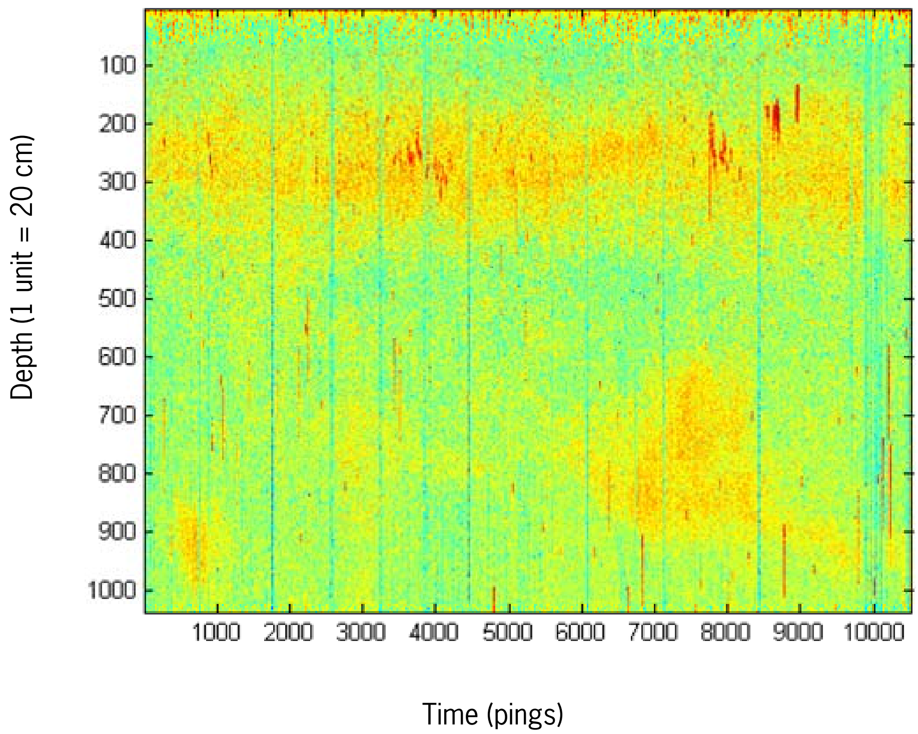
The work executed during the present project consisted in building a front-end and a back-end to these algorithms developed by IMR. The front end fully automatically reads in the datasets (which is only limited by the number of datasets available), while the back-end translates the analysed output into a format that is suitable to be stored within a database. Therefore, each acoustic file is divided into depth layers of 50 meters and distances covering 0.5 miles. Density estimates are aggregated within these blocks. This is in accordance with the analyses performed using Echoview. Further, headers and column names are added to an output file, which carries a unique name. The aggregated data is stored in the output file as well and is automatically written to disk.

A comparison was undertaken to verify whether the output produced by this routine was similar to the output produced by Echoview. Unfortunately, some small differences were found. A more in depth examination of how both Echoview and the Matlab routine process the raw acoustic data is required to identify the exact reason for this discrepancy and solve this problem.

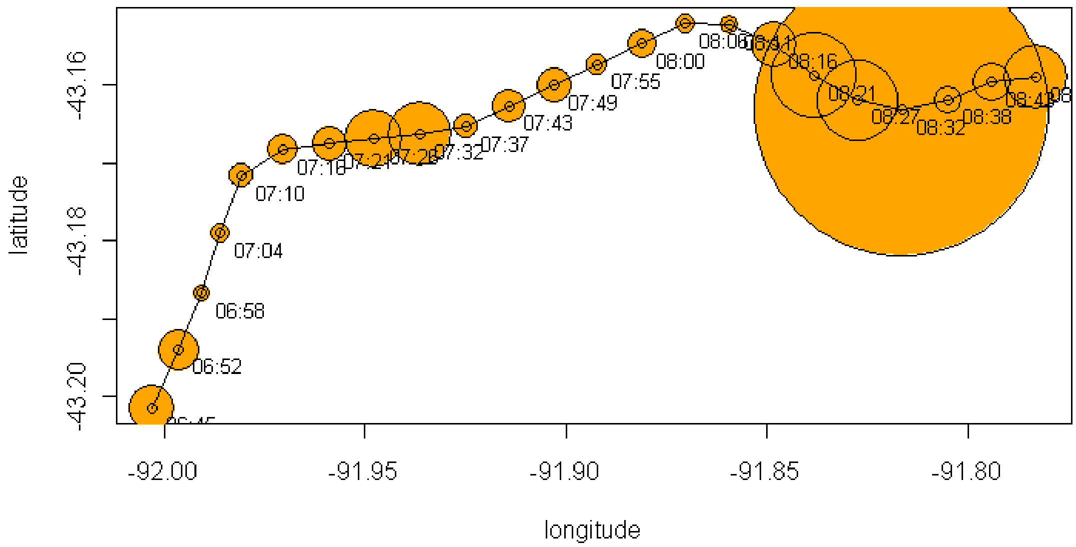
It has not been tested whether the data output from the algorithm designed here is suitable to be imported into the central database described in the next section. However, it is assumed that no major problems will occur as both the output design of Matlab and input for the database have been tuned to fit to each other.

3.1.2 Example

The figure below gives an example of acoustic data after it was analyzed by the Matlab algorithm. The data on this figure correspond to a sample of about 2 hours of data set collected onboard the pelagic trawler. The X-axis represents each sound emission by the sounder – so-called “ping”, and can be assimilated to a time line. The Y-axis represents the depth. The color on the plot is representative of the amount of energy/sound (in Db) which was reflected at the different depths for each ping. A filtering of the raw acoustic signal is realized by keeping only the back-scattered acoustic energy above a given threshold. This is done in order to remove what is considered to be noise, or acoustic detection corresponding to plankton, and keep only the detection which is supposed to be due to the fish. The red patches around depth 300 (which is 60m) and at time 3000 and 9000 are fish aggregations.



Once filtered as described above, the data is then further aggregated into NASC (nautical area scattering coefficient) : the acoustic energy is summed for different depth layers (0-50m, 50-100m etc.) and over one nautical mile of distance. The NASC is the standard acoustic measure which is analyzed in the conventional acoustic surveys. The figure below gives an illustration of the value of the NASC (integrated over depth) corresponding to the same sample of the acoustic data as on the figure above. The track of the vessel is represented by the continuous line, and the sum of the acoustic energy recorded every nautical mile (with corresponding time) is depicted by the circles.



3.2 Storage of acoustic data in Frisbe, the IMARES fisheries research database

In the framework of this project, a database model for the storage of the analyzed acoustic data in Frisbe (development environment) was designed and implemented. This model takes into account the current database model of Frisbe so that the acoustic data can fit into this model instead of creating a separate set of tables with no link to the current model.

Do to so, we first designed and built a preprocessing software that takes an export file as input (i.e. an output of the Matlab algorithm described in the previous section) and produces as an output a file with the data that is necessary for the database import.

Then, a database import software was designed and built. This software takes the output of the preprocessing phase as input and imports the records in this file into the appropriate tables of Frisbe.

In order to integrate the acoustic data into Frisbe it was necessary to define data that has a similar concept as a station in Frisbe (e.g. sampling station in a scientific survey). A station can be regarded as an entry point for all data processing activities in Frisbe. The marks that are set in the acoustic datastream every mile are very similar to a station: they are set on a certain date, time and position. So these marks are chosen as a station. It still has to be decided whether this approach is valid. The current implementation as described above is based on this approach.

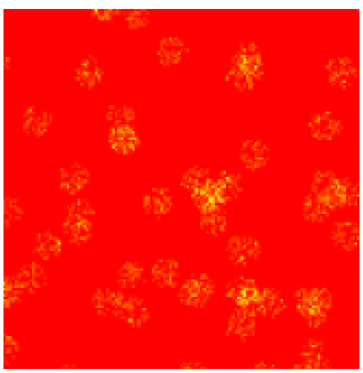
During the course of this project is was not possible to fully test the data model and the software

4. Investigating the potential use of fishing vessels information to estimate stock abundance using a fishing simulator.

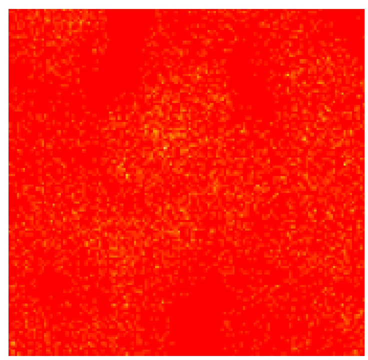
4.1 The fishing simulator

4.1.1. Representation of the resource

The simulated fishing vessels operate on a grid (here 500 cells in latitude by 500 cells in longitude) where the cells are given a value corresponding to the abundance of fish in that specific cell. The spatial distribution of the resource was generated as a Neyman-Scott cluster process : schools are distributed in clusters of schools, the centres of these clusters being randomly distributed on the grid following a Poisson process. The schools do not mover location. The number of schools in a given cluster varies randomly between 5 and 800. The value (fish abundance) of each school also varies randomly between 1 and 20. The degree of aggregation of the resource depends on the value chosen for the radius of the clusters : in the example below a radius of 6 cells results in a very clustered distribution, while a radius of 20 cells results in a more scattered distribution.



radius : 6 cells



radius : 20 cells

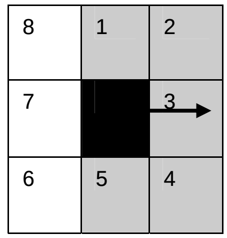
4.1.2 Model of fishing behaviour

The simulator was designed to represent the searching and fishing activity of pelagic trawlers. The vessels in the model behave according to a few simple rules. A vessel scans permanently a half disc area of the ocean with a sonar. As long as no fish aggregation is found, the vessel continues his route straight ahead. When a fish aggregation is detected in the scanned area, the vessel changes of direction to go to this aggregation and fishes it. If there is no aggregation in the scanned area, the vessel continues straight ahead on its new heading. If there is an other aggregation, it changes is heading again toward this aggregation and goes to fish it.

The vessels have no memory (e.g. they don't remember the areas where they had good or bad catches) and they don't communicate with each other.

At a given time, the position of the vessel is given by the coordinates of the cell it occupies in the spatial grid. At each time step, the vessel moves in one the 8-neighboring cells. The 8 possible directions to each of these 8 cells are represented by a number ranging from 1 to 8 as represented on the figure below.

The sonar scans at one cell of distance, and from 90° on the left of the vessel to 90° on the right. The area scanned is hence represented by 5 cells as illustrated on the figure below ;



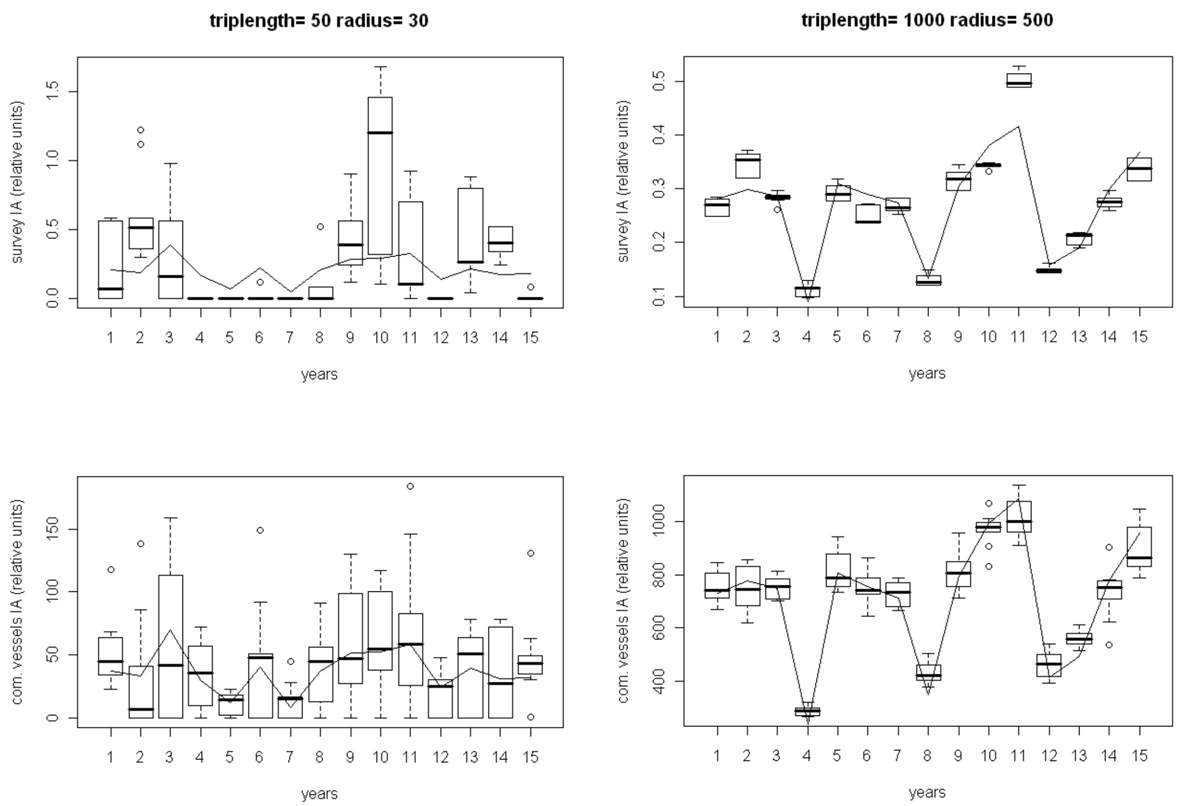
Coding for the 8 possible directions from the cell (in black) occupied
by the vessel and illustrations of the shape of the scanned area (in grey)
for a vessel heading in direction 3 (black arrows).

The vessel progresses on the grid towards the cell with the highest value in its scanned area or continues straight ahead when no fish is detected. The position of the vessel and the values of the cells visited are recorded continuously.
Alternatively, the simulator can also run transects to simulate an acoustic survey.

4.2. Example of application

In this example, we compare the accuracy of abundance estimates based on commercial vessels information and based on survey information and we investigate how their accuracy vary according to the sampling effort and the degree of spatial aggregation of the resource.
For the 5 different degrees of aggregation of the resource (radius in {3, 6, 10, 20, 50}) , we simulate 15 different datasets (i.e. same as different years, with different stock abundances).

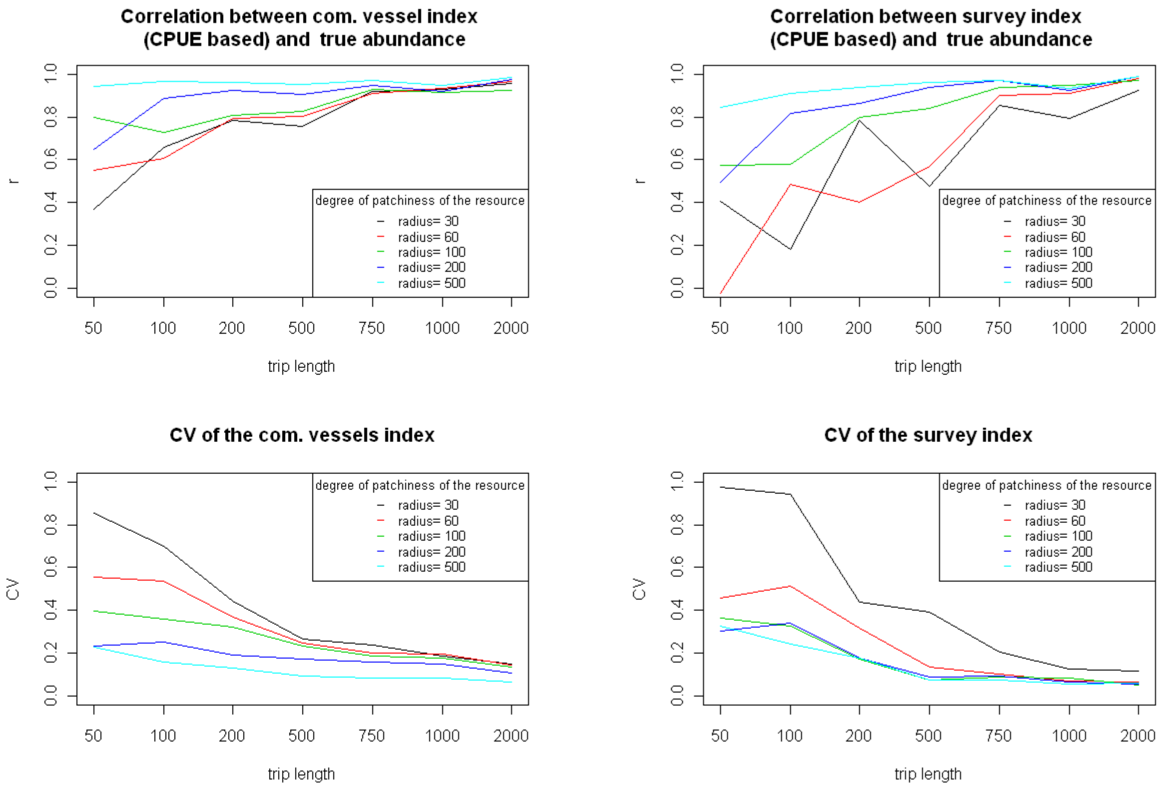
For each dataset, we run a survey and the commercial fishing activity (5 vessels fishing simultaneously) with a given sampling effort. The value of the schools fished and seen (in the 1 cell radius of our sonar) are stored and abundance indices are computed, both from the schools fished and the schools seen. For each of the 15 years, the simulation is run 10 times. This experiment is reproduced 7 times with different sampling efforts (length of the survey , or fishing trip in {50, 100, 200, 500, 750, 1000, 2000}). We investigate then the correlation between the abundance estimates and the true abundance and the CV of the abundance indices



The figure above gives 2 examples of different combination of trip length and radius values. The box plots represent the distribution of the abundance estimates (sum of the catches) from the 10 repetitions done a given year. The black line represents the variation of the true abundance (rescaled).
On the left, the sampling effort is very low and the resource is highly aggregated. The abundance index from the survey (above) is poorly correlated to the true abundance, and the estimates are fairly imprecise (width of the boxplots). The index derived from the commercial vessels data shows an better correlation with the true abundance but is also very imprecise.
On the right side, the sampling effort is very high and the resource is very scattered. The survey estimates correlated quite well with the true abundance (except for small departures in years 2, 6 and 11), and is very precise. The correlation is even better for the index derived from the commercial data, but with a slightly greater uncertainty.

The figure below shows how the correlation between abundance indices and the true abundance and the uncertainty of these indices vary according to sampling effort (trip length) and to the aggregation of the resource (radius). Both for survey (left) and commercial vessels (right) indices, the correlation with true abundance increases when the sampling effort increases while the CV decreases. For a given effort, a better precision of the indices and higher correlation with true abundance are observed when the resource is scattered than when it is clustered.

The commercial vessels based index exhibits a higher correlation with the actual stock abundance than the survey index. When the sampling effort increases, the difference of performance between the two indices tends to be less important. The precision of the indices (inverse of the CV), is higher for the commercial vessels index when the length of trip is small. However, if the sampling effort is high, the survey seems to produce a less variable index than the commercial vessels.



4.3 Further developments

4.3.1 Set the simulator in real dimensions, using North Sea herring as case study

In the application above, the simulator works dimensionless and the conclusions drawn regarding the quality of the abundance indices don't apply to a real situation.

Many parameters have to be incorporated to make the simulator more realistic :

- size of simulation area
- size of the grid (i.e. spatial resolution of the model)
- characteristics of the sonar (range, angle)
- size of the fish schools, and characteristics of their spatial distribution

Data from the acoustic survey of NS herring could be used to determine the size of the schools and the characteristics of the spatial distribution of the resource.
A crucial choice would be to decide of the spatial resolution of the model. One important question is to decide whether a cell should represent a school or represent the biomass of all the schools present. A better knowledge of the behaviour of the fishing vessels, particularly knowing whether they target isolated schools or aggregations of schools, would be needed to develop these ideas further.

4.3.2 Compare different types of indices

The most simple abundance index which can be derived from the commercial vessels data is the sum of the catches or fish schools seen in the scanned area (possibly divided by the length of the trip if it changes between the years). However, we could think of other types of indices. For instance, since the data collected by the commercial vessels are geolocalized, geostatistical techniques could be used to derive an abundance index.
The simulator could be used to compare the accuracy of these different indices.

4.3.3 Investigate different data collection strategies

In the example presented above, fishing vessels do not modify their behaviour and fish in a uniform manner. One can imagine that the fishers could be willing to use part of the trip for scientific purpose. For instance, the fish-processing time could be used to carry out “mini-surveys” following transects. Alternatively, steaming to the fishing grounds and back to the harbour could be done doing transects or zigzags to increase the area prospected. This simulator could be used to investigated the benefits of such alternative data collection strategies.

5. Conclusion

The present project can be viewed as a pilot study aimed at investigating the potent use of acoustic data from commercial pelagic trawlers for the purpose of stock assessments.
During this project, the main technical issues related to the collection, processing and storage of the data were addressed and protocols and tools related to these tasks were developed. Methodological questions related to the use of such data to estimate stock abundance were also tackled. Besides the work accomplished, some important questions that need to be followed up were identify.
The first result of the project was that it was relatively easy to collect data from a pelagic trawler. This experience also pointed out that there was a likelihood of problems occurring during a fishing trip. This would need to be taken into account when designing protocols for a routine data collection scheme, and may result an opportunistic data collection strategy, rather than a well-planned one. This also suggests that a good cooperation and communication with the crew would be crucial to the success of this approach. Furthermore, an investigation of the equipment used on board the different vessels would be necessary to assess which segment of the pelagic freezer trawler fleet could potentially be used.
The raw data has to be processed to convert acoustic detection into information on the biomass of fish detected by the sounder. A routine in Matlab was developed in this project, which handles the raw data, runs a Norwegian algorithm to process them and prepares an output file in the suitable format. This first attempt to analyse commercial acoustic data suggests that more information on the characteristics of the data is needed. For example, questions related to how the fishers use their equipment (e.g. do they change the ping frequency while using the sounder?) need to be answered. Knowing whether/how their sounders are calibrated is another important issue. As for successful data collection, an open dialog with the fishers is required.
Important scientific questions also need to be investigated before a quantitative use of commercial acoustic data can be envisaged. For instance in scientific surveys, samples are taken to determine the species composition and size of the fish. This information, which is needed to convert acoustic energy into biomass of fish, is not necessarily available for commercial acoustic data. Further investigation is

needed to decide whether techniques based on the comparison of the data recorded at the different frequencies could be used to overcome this problem. Alternatively, when available, could information on the composition of the catch be used to provide information on the species and size composition?
Along with the issues of the processing of the raw acoustic data, further questions still exist related to how the processed data could be used to derive abundance indices. In the present project, a simulator of the behaviour of the pelagic trawlers fishing a spatially distributed resource was developed to generate fake acoustic data. This tool can be used to investigate the accuracy but also potential biases in the abundance estimates caused by nature of the commercial acoustic data. Further use of this simulator can help answer the following question :

- how much information is needed to reach a desired level of accuracy?
- in which situation is there a risk of bias (e.g. depending on the aggregation of the resource, on the vessels behaviour)?
- which statistical methods are the most suitable to derive an abundance index from this data and reduce bias?
- would the abundance index be improved if fish processing time is used to perform mini-surveys?

Finally, further research is required into the usefulness of abundance indices from commercial acoustic survey for stock assessment. Such indices may not have the standard proprieties of conventional survey indices. The main issues being that fishers target high density of fish, and generally don't cover the entire area where a stock is present which can cause bias in the estimates. Once those potential flaws are identified (using the simulator), new methods need to be found on how to correct for those biases when calculating abundance indices from spatial abundance estimates. At the same time, the relevance of the current stock assessment method to a new type of survey index needs to be addressed.

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Justification

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The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

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